

Research Article

Assessing the Acceptability of Winged Termites (*Alate mothlaronisoptera*) as an Alternative Food in Northern Uganda

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Abstract

The study aimed at assessing the acceptability of winged termites as an alternative food in northern Uganda. The study objectives were: to determine the socio-economic factors that influence consumer acceptance of winged termites, and to assess the contribution of winged termites' consumption acceptance on food security in Northern Uganda. The study employed a cross-sectional survey design, where both qualitative and quantitative approaches were used. The sample comprised of 384 community members, 14 agricultural officers, 20 health workers, and 10 nutritionists. Community members were selected using simple random sampling, while the other categories were selected purposively. Data was collected by use of questionnaires and interview guides. Quantitative data was analyzed using SPSS software and thematic content analysis was used to analyze qualitative data. Study findings revealed one-unit increase in consumers' disease association with winged termites, the odds of the outcome variable increase by a factor of 0.045. This means that consumers with winged-insects' perception of having diseases have a probability of 4.5% of accepting the consumption of winged termites. However, the associated p-value (Sig) of 0.751 suggests that the effect of disease perception on acceptance of consumption of winged termites is not statistically significant at the conventional 0.05 significance level implying that the null hypothesis would prevail that disease perception does not have a significant effect on consumers' acceptance of winged termites. Thus, for every one unit of increase in the concerns of the consumers' health perceptions, the odds of consuming winged termites would decrease by a factor of 0.594. This means that consumers who are biased about their health by consuming winged termites have a probability of 59.4% of not consuming the winged termites hence not accepting the consumption of winged termites. Basing on the study findings, it is therefore concluded that the acceptability of winged termites has an influence on food security in northern Uganda. The study therefore recommended that there is need for commercialization of edible insects' value chain, and educating consumers about the environmental and nutritional benefits of winged termites; and areas of further research were suggested on the choice experiment can be used instead of ANOVA, regression model and a further study.

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Keywords

Assessing, Acceptability of Winged Termites, *Alate mothlaronisoptera*, An Alternative Food

1. Introduction

Globally, access to sufficient and healthy food is both a fundamental human right, and a prerequisite for people to achieve their full physiological potential. Availability of enough and healthy food also determines people's economic activities [4, 22]. Policy makers, therefore prioritize policies aimed at promoting food access and utilization. However, availability of enough and healthy food remains a serious challenge. This is because the global population continues to grow rapidly, and is estimated to reach nine (9) billion by the year 2050 [13]. The current food production levels therefore need to increase drastically to satisfy the growing population. At the same time, land and other natural resources that play a central role in food production are becoming increasingly scarce, overused and less sustainable [36]. Intensive farming systems like proper crop and livestock husbandry, proper use of inorganic fertilizers, chemicals and improved seeds, genetic selection, and recently genetic engineering, for example, development of genetically modified organisms (GMOs), are being used to increase food production. However, increasing yields through agricultural intensification (for instance, increased use of inorganic fertilizers and non-selective chemicals) greatly pollutes the environment [6]. In the long run, intensive agriculture can reduce food production unless sustainable approaches are employed [4]. Alarming, global warming is gradually decreasing the areas used for food production worldwide [10]. The climate change and the environmental destruction from industrial development have continually affected the food productivity negatively [42]. Therefore, innovative ways of producing more food are required and newer (alternative) food sources that increase dietary diversity becomes very important. Among the alternative food sources, winged termites have recently received increased attention from both public and private organizations [27, 15]. Winged termites are a rich source of protein that can improve human diet, especially for individuals suffering from poor nutrition due to protein deficit. Insects often contain relatively more protein and minerals than meat, hence insect-based foods are a potential superior alternative to conventional meat. Consumption of insects also conserves the environment because they are exceptionally efficient in converting what they eat into consumable tissue [29]. Insects feed on a wide range of plants, thus rearing them requires far less space and generates less greenhouse gases compared to conventional livestock [41]. The collection and consumption of winged termites by humans have long been known and dates back to prehistory [1] winged termites were consumed in China 3,200 years ago. Moreover, the capturing,

processing, transporting and marketing of winged termites can provide income and livelihood opportunities around the world [28]. Consumption of insects has been a common practice in many cultures for centuries [12]. In recent times, winged termites are consumed in different forms by an estimated two billion people across Africa, Asia, Central and South America, and Australia not only because they taste good but also because they are a nutritious and inexpensive food source as well as being rich source of protein that improve human diet [11]. Winged termites are recognized as a valuable source of protein and other nutrients [41]. In addition, they are easy and cheap to produce especially for those people with limited land, requiring little feed, water and space [5]. These properties make production of winged termites an attractive option for people who lack access to land or resources for farm inputs, especially in areas where there is limited access to nutritious food [35]. Winged termites are institutionally accepted as a food in many regions and historically consumed [31]. Providing sufficient nutritional value for humans [44]. However, the rapid increase in food production through technological advancement has rarely prioritized winged termites in our diets [14]. The increased scrutiny of winged termites is part of multifaceted strategies for achieving global food security [40]. In general, insects have high protein content and excellent production efficiency compared with other conventional food groups [26]. This characteristic is particularly valuable given that future protein consumption is expected to increase, amidst decline in food supply [33]. Presently, food production systems place a heavy burden on the environment [18] as evidenced by the residential sector (major base for food production systems) which is responsible for about 50% of all environmental impacts of human activity [16]. Contrastingly, insect farming has less environmental impact, faster growth rates, high production efficiencies, and high protein quality thus making them one of the best alternative food resources; however, all these characteristics depended on feed sources, species being farmed, and other rearing practices and conditions [7]. Additionally, production and consumption of winged termites in Africa offers a potential opportunity for new sources of nutrition and income generating activities for both community members and producers [5]. However, because production of winged termites is still a very new activity, there are many questions that need to be answered in order to be able to provide a realistic assessment of the feasibility and desirability of initiating edible insect production in most Sub-Saharan African countries [32]. These questions pertain to the attitude of

community members towards the consumption of winged termites, to input markets (i.e. identification of suitable feed), the most suitable production methods and markets for various insect-based products [39]. More than 1.5 billion people in Africa eat winged termites as a common dietary habit and their collection and sale are an income generating activity for many women and youth in rural areas [11]. Furthermore, winged termites and products are already available in other East African countries like Kenya. These insects can be reared and multiplied easily in small spaces within a short period of time [8]. In addition, termites are part of the traditional diet in western and Lake Victoria region of Kenya [24]. Moreover, these insects contain protein and other important nutrients that can help reduce nutritional deficiency. The use of winged termites as human food can thus result in a more energy-efficient food production and facilitate environmental conservation and offer livelihood opportunities for poor households since insect harvesting/rearing is a low-capital investment option [43]. Interestingly, in Eastern Africa, protein-rich edible insects are increasingly becoming a viable and sustainable alternative to animal and plant protein for improved food and nutrition security; however, for the economic, social and environmental benefits of winged termites to be realized, consumers must accept them [38]. Acceptance in this context implies that winged termites become a common component of general diets and that winged termites' value chains forms important livelihood opportunities among the targeted communities. The dearth of knowledge regarding consumer acceptance could pose a big challenge to such novel dietary interventions [39]. Uganda is host to more than one million refugees, who have limited access to land and resources, and suffer from severely limited access to a nutritious diet [32]. If the right business model is developed, production of winged termites could become an important source of income for refugees, and at the same time provide a valuable source of nutrition [11]. Developing countries, Uganda included are faced with increased population growth and urbanization resulting in high demand for food, especially animal-based protein [24]. The dilemma is how to sustainably meet the rising demand for animal-based protein in the face of climate change, environmental degradation as well as land and water scarcity [17]. The popular current animal-based protein sources are milk, meat and eggs whose supply is insufficient, unsustainable and relatively expensive [25]. Entomophagy, the collection and consumption of insects as food could be a possible solution for developing economies, Uganda included with several advantages [31]. Winged termites are nutritious, always available and have a lesser ecological footprint [9]. In line with the above, [38] argued that winged termites are receiving substantial attention in most parts of Uganda, and these because of their potential as a significant future food source of high nutritional value and with significant environmental benefits. Winged termites are rich in Vitamin A, Vitamin C, fat while anti-nutrient components are low [24]. Winged termites are usually roasted and eaten as

food, mostly during the rainy season. Similarly, winged termites are being promoted in northern Uganda and other regions as an alternative source of proteins to meat, but research on its prospects and acceptance by the households has been rare and sporadic [34]. On the other hand, Higenyi, J revealed that over 51.9% of consumers of winged termites in eastern Uganda prefer fried and seasoned termites with spices, while 30% consume them fried with seasoning; 12.8% prefer cooking the termites in sauce and 5.3% eat them freshy to fully benefit their nutrients [17]. Most of the studies on insect-based foods largely focus on the nutritional aspects and the potential benefits of entomophagy [15]. The underlying theme of these studies is that consumers are rational and therefore, should accept winged termites based on the implied benefits. Acceptance in this context implies that winged termites become a common component of general diets and that winged termites' value chains forms important livelihood opportunities among the targeted communities [34]. With the existence of winged termites in northern Uganda, cases of food shortage still prevail among rural communities [11]. The shortage of knowledge regarding consumer acceptance could pose a big challenge to such novel dietary interventions. The current study addressed these inadequacies in literature by employing the subjective expected to determine consumer acceptability and intentions to consume winged termites as an alternative source of foods. This therefore, called for more studies geared towards understanding and assesses the acceptability of winged termites as an alternative food source in Northern Uganda.

2. Statement of the Problem

Ideally, they are being promoted in northern Uganda as an alternative source of proteins to meat, but research on its prospects and acceptance by the households has been rare and sporadic [13]. Still, the food poverty rate stands at 42 percent in Northern Uganda. The regional residents mainly depend on milk and eggs for animal-based protein supply [17]. Still, these sources are insufficient, unsustainable and expensive for the unemployed poor locals who are the majority in northern Uganda. These reasons have made access to sufficient and sustainable animal-based proteins by most households' difficult leading to malnutrition. Resorting and promoting the use of winged termites as an animal-based protein source is a potential sustainable solution [21]. However, scientists have now the challenge to promote the use of these insects as food products. The information on the consumers' attitude/perception of it, the factors influencing its acceptance and quantity consumed is scanty [17]. Most of the studies on insect-based foods largely focus on the nutritional aspects and the potential benefits of entomophagy [15]. The underlying theme of these studies is that consumers are rational and therefore, should accept edible insects based on the implied benefits. Despite many benefits of entomophagy, consumer acceptance remains

a major barrier to the adoption of diets based on winged termites in Northern Uganda [39]. The limited information regarding consumer acceptance could pose a big challenge to such novel dietary interventions. There is no doubt that the world has to provide food for its inhabitants, but how to meet the increasing demand in the future remains an open and critical question. Hence, the main aim of this study was to assess the acceptability of winged termites as an alternative food source in Northern Uganda.

3. Results and Discussion

This chapter is detailed with data presentation, analysis and interpretation of results, as well as gave detailed discussion of results. The study findings are presented, following the study objectives namely; determining the socio-economic factors that influence consumer acceptance of winged termites, and assessing the contribution of winged termites' consumption on food security in Northern Uganda. The study presents descriptive results from questionnaire in form of mean to show the central tendency of responses in the likert scale questions. Interview results were also obtained to explain qualitatively about the acceptability of winged termites as an alternative food source in form of quotations and narrative statements as per respondents' views in regard to each objective of the study and these supplemented results from the questionnaire. The study also presents Factor Analysis using Logit regression model and R-Square from the Model summary table; P-value from the ANOVA table and Beta values from Table of Coefficients respectively; and further presented showing mean and standard deviation. This showed the nature of relationship between variables and the magnitude of effect the independent variables have on dependent variable. The chapter also presents the response rate, which shows the actual number of respondents that participated in the study and further the background information of respondents which showed the common demographic respondents characteristics who participated in the study.

4. Response Rate

All the questionnaires (400) that were distributed, and only 384 of them were filled, collected and used. These (400) were distributed so that the first 384 to be picked considered for the study. The questionnaire survey response rate was 96%. Forty four (44) participants were interviewed and these were for census sampling. The response rate for interviews was 100%. The overall response rate was 98%, therefore it presents adequate, accurate, valid and reliable data on the study variables in two districts in northern Uganda thus the study gave generalized results. This response rate is above the 60-70% response rate as recommended by the Guttman Institute (2006) for a study to be considered as one with satisfactory

results. The high response rate is attributed to the well-designed questionnaire, the study topic and the enthusiasm of the researcher which aroused the interest and positive attitude of the respondents.

5. Demographic Characteristics of Respondents

The demographic characteristics looked at the respondents' distribution across gender, age bracket, highest education level, marital status, religion, and occupation (Table 1).

Table 1. Demographic Characteristics of Respondents.

Demographic feature	Frequency	Percentage (%)
Gender		
Male	218	50.9
Female	210	49.1
Highest level of education		
Primary level	140	32.7
Secondary level	203	47.2
University	60	14.2
Others (never been to school)	26	6
Age Bracket		
18-28 years	36	8.4
29 – 39 years	89	20.8
40 – 50 years	168	39.3
51 – 61 years	121	28.2
Above 61 years	14	3.3
Marital Status		
Married	224	52.3
Single	136	31.7
Divorced/separated	38	8.8
Others (widower/widows)	30	7.2
Religion		
Catholic	194	45.3
Protestant	146	34.2
Islam	20	4.7
Others (Born again)	68	15.8
Occupation		
Small business/self employed	340	79.4

Demographic feature	Frequency	Percentage (%)
Retired	14	3.3
Student	18	4.2
Civil servants	56	13.1

Source: Primary data, 2022

Majority of the respondents (50.9%) were male while the female constituted 49.1% of the total number of respondents (Table 1). Therefore, majority respondents involved in winged termite's business were men. However, women have increasingly joined winged termite's business despite gender stereotype.

Majority (47.2%) of the respondents had secondary level education qualification, followed by 32.7% with primary level, and only 6% never been in school. This implied that most of the community members involved in winged termites eating and business in northern Uganda had secondary level of education.

Majority of respondents (39.3%) belonged to age bracket of 40 – 50 years, followed by 28.2% in age bracket of 51 – 61 years, and least (3.3%) were above 61 years. The implications are that each of the respondents was from different age group or generation differences with different knowledge and perception about winged termites as an alternative food source. Therefore, majority respondents were aged 40-50 years, hence have the energy to perform or get involved in winged termite business if the environment favors them.

Majority of the respondents (52.3%) were married, while 31.7% of the respondents were single, and a paltry (7.2%) were widower/widowed. These implies that most of the respondents were married and these are the category of people with families, followed by single who were also mature boys involved in winged termites vending.

In terms of religious affiliations, majority of the respondents (45.3%) were Catholics, followed Protestants (34.2%), then, others (Born again) (15.8%) and lastly, Islam (4.7%) of the respondents. This implies that respondents were from different categories of religious affiliations; stating that most people in northern region are Catholic affiliated.

Lastly, majority of the respondents (79.4%) were involved in small businesses, winged termites vending inclusive, thus self-employed, 13.1% were civil servants and the least of the respondents (3.3%) were retired.

The researcher went ahead to present the production and post-harvest handling, month of the year the termites are available, participation in collection of winged termites, methods of winged termites' collection and ways preserving winged termites after collecting them (Table 1).

Table 2. Information on Consumption of Winged Termites.

Consumption of winged termites	Percentage
Yes	84.4%
No	15.6%
Months of the year the termites are available	Percentage
March, October and November	100%
Participation in Winged Termites Collection	Percentage
Yes	61.4%
No	38.6%
Methods of winged termites' collection	Percentage
Direct collection by breaking termite mounds	83.1%
Trapping of termites in containers	16.9%
Ways of preserving winged termites after collecting them	Percentage
Drying and crushing them	35.3%
Salting	29.7%
Cooking	17.1%
Frying	11.5%
Change them into a paste	6.4%

Source: Primary data, 2022

Majority of the community members (84.4%) who were involved in this study accepted to be consuming winged termites, whereas only 15.6% didn't.

Availability of the winged termites was in the month of March, October and November which coincides with the rainy seasons.

Most people in the community 61.4% participated in collection of winged termites and probably automatically consume them. However, 38.6% of the respondents revealed that they have never been involved in collection of winged termites.

Interrogating the 61.4% that are involved in winged termites' collection revealed that they either do direct collection after breaking the termite mounds (83.1%) or trap the termites in containers. These are usually found at sites with plant debris or dead animals, and can be spotted through the characteristic soils associated with termite tubes. The soil is scraped with a hoe and a trap is placed of the soil. The trap consists of a container, overturned and filled with humid organic matter.

The study revealed different post-harvest handling techniques 35.3% of the respondents dried and crushed after collection, while 29.7% salted; cooking was preferred by 17.1%, frying by 11.5% while changing the form into a paste was practiced by 6.4% of the respondents. The community members involved in collection of winged termites and vending ap-

ply different methods to preserve them for proper consumption and trying to meet the market demand.

1.6 Descriptive Results on the Social Economic Factors that Influence Consumer Acceptance of Winged Insects: The variables were rated with the extent of agreement or disagreements i.e. strongly agree to strongly disagree, and this was further explained with the help of Principal Factor Analysis. Findings from 384 community members are indicated in [Table 2](#).

[Table 3](#) represents the descriptive statistics on the socio-economic factors that influence consumer acceptance of winged termites in Northern Uganda. The results show that

98.9% of the respondents accepted to the statements that the income of the consumers as a major socio-economic factor that influence consumer acceptance of winged termites in Northern Uganda (Mean=3.67 and standard deviation 1.142); followed by availability of winged termites revealed by 95.8% of the respondents (Mean=4.45 and standard deviation 0.890); education of the consumers revealed by 88.5% of the respondents (Mean=4.33 and standard deviation 0.872); household size of the consumers revealed by 83.5% of the respondents (Mean=4.41 and standard deviation 0.805); and lastly, potential allergic reactions and its side effects revealed by 82.3% of the respondents (Mean=3.94 and standard deviation 1.129).

Table 3. The Socio-economic Factors That Influence Consumer Acceptance of Winged Termites in Northern Uganda.

Statement	Extent of (dis)agreement					Mean	Std. Dev
	SA	A	NS	D	SDA		
	f (%)	f (%)	f (%)	f (%)	f (%)		
Income of the consumers	30 (78.6)	78 (20.3)	4 (1.1)	- (0)	- (0)	3.67	1.142
Availability of winged termites	286 (74.5)	82 (21.3)	16 (4.2)	- (0)	- (0)	4.45	.890
Education of the consumers	260 (67.7)	80 (20.8)	40 (10.4)	4 (1.1)	- (0)	4.33	.872
Household size of the consumers	252 (65.6)	69 (17.9)	50 (13.1)	13 (3.4)	- (0)	4.41	.805
Potential allergic reactions and its side effects	254 (66.1)	62 (16.2)	51 (13.3)	17 (4.4)	- (20)	3.94	1.129
Cost of the product (price)	242 (63.1)	56 (14.6)	54 (14)	32 (8.3)	- (0)	4.63	.615
Winged termites consumption contributes eating of heavy metals that cause adverse health effects	228 (59.4)	48 (12.5)	55 (14.3)	53 (13.8)	- (0)	4.42	.592
Nutritional content of winged termites	213 (55.5)	50 (13.1)	49 (12.7)	56 (14.6)	16 (4.1)	4.21	.576
Individuals' culture and customer attitude	204 (53.2)	55 (14.3)	51 (13.2)	50 (13)	24 (6.3)	4.25	.647
Proximity of market place for winged termites	189 (49.2)	47 (12.1)	54 (13.3)	60 (15.6)	34 (8.8)	4.11	.724
Taste of the winged termites	184 (47.9)	51 (13.3)	56 (14.6)	63 (16.4)	30 (7.8)	3.12	1.155
Risk of pesticide food poisoning	169 (44)	52 (13.6)	49 (12.7)	69 (17.9)	45 (11.8)	3.65	1.074
Winged termites are considered to be mycotoxins (food contaminants)	152 (39.6)	57 (14.8)	59 (15.5)	70 (18.2)	46 (11.9)	4.33	.872
Consumers of winged termites experience antinutrients	147 (38.3)	49 (12.7)	58 (15.2)	65 (16.9)	65 (16.9)	4.41	.805
There are cases of transmission of diseases or parasites to humans from the consumption of winged termites	138 (35.9)	48 (12.5)	60 (15.6)	70 (18.2)	68 (17.8)	3.94	1.129
Winged termites contribute to transmitting parasitic foodborne diseases	129 (33.6)	45 (11.7)	61 (15.8)	75 (19.5)	74 (19.3)	4.63	.615

Source: Primary Data (Community members) 2022

6. Descriptive Results on Principal Factor Analysis

An exploratory factor analysis was run by the researcher to find out the factors that influence consumer acceptance of

winged insects in Northern Uganda. The principal factor analysis resulted into four factor loadings which the researcher coded as insect disease perception, consumer health perception, socio-economic factors, and consumer behavior as shown in the table below.

Table 4. Factor Loadings for Factors Influencing Consumer Acceptance of Winged Insects.

Code		Insect disease attachments	Consumer Health Perception	Consumer Societal Perception	Socio-economic factors
SE14	Consumers of winged termites experience antinutrients	.745			
SE16	Winged termites contribute to transmitting parasitic foodborne diseases	.626			
SE15	There is cases of transmission of diseases or parasitoids to humans from the consumption of winged termites.	.527			
SE12	Risk of pesticide food poisoning	.489			
SE13	Winged termites are considered to be mycotoxins (food contaminants)	.452			
SE5	Potential allergic reactions and its side effects		.701		
SE7	Winged termites' consumption contributes eating of heavy metals that cause adverse health effects		.503		
SE8	Nutritional content of winged termites		-.495		
SE10	Individuals' culture and customer attitude			.889	
SE3	Education of the consumers			.543	
SE9	Cost of the product				.699
SE6	Proximity of market place for winged termites				.671
SE11	Taste of the winged termites				.656
SE1	Income of the consumers			-.453	.553
SE4	Household size of the consumers				.538
SE2	Availability of winged termites				.525

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Table 4 shows that consumers had insect disease attachments to their reasons for non-acceptance of consuming winged insects. This included customers who attached consumption of winged insects to experiencing anti-nutrients (74.5%), those with the perception that the winged termites contributed to transmission of parasitic foodborne diseases (62.6%), transmission of parasitoids to humans (52.7%), risk of pesticide food poisoning (48.9%) and the perception that winged termites were food contaminants (45.2%).

Additionally, there were customers with health perceptions such as allergic reactions arising from consuming termites

(70.1%), eating of heavy metals (50.3%) and the non-nutritional content of winged termites (49.5%).

Furthermore, the table showed that societal perception contributed to whether or not consumers would buy winged termites, for instance perception, attitude of the customers and individuals' culture (88.9%) and education of the consumers about the termites (54.3%).

Finally, there was socio-economic factors which involved the cost of the termites (69.9%), proximity of the market for winged termites (67.1%), taste of the winged termites (65.6%), income of the consumer (55.3%), size of the consumers'

households (53.8%) and availability of the termites (52.5%). The availability of termites for consumption tends to change consumer behavior to buy them.

In order to determine the acceptance of the termites by consumers in Northern Uganda, the study adopted the 4 factor loadings, that is, consumers' disease attachment to insects, consumers' health perceptions, consumers' societal perceptions, and socio-economic factors. This was incorporated in the logistic regression as presented in Table 5 below.

7. Logistic Regression

In order to determine the level of prediction and significance of the socio-economic factors that influence consumer acceptance of winged termites; the researcher used a logistic regression model analysis to determine specific significance levels of socio-economic factors that influence consumer acceptance of winged termites. The researcher used winged termite collection as the predictor in the logistic regression model as presented below.

Table 5. Logistic Regression Analysis on Factors for Consumer Acceptance of Winged Termites.

Variables in the Equation	B	S.E.	Wald	df	Sig.	Exp (B)
Disease Perception	.045	.141	.101	1	.751	1.046
Health Perception	-.594	.152	15.291	1	.000	.552
Societal Perception	.843	.154	29.806	1	.000	2.324
Consumer Behaviour	1.336	.168	63.391	1	.000	3.805
Constant	1.066	.143	55.542	3	.000	2.903

a. Variable (s) entered on step 1: Disease Perception, Health Perception, Societal Perception, Consumer Behaviour.

Table 5 shows that for a one-unit increase in consumers' disease association with winged termites, the odds of the outcome variable increase by a factor of 0.045. This means that consumers with winged-insects perception of having diseases have a probability of 4.5% of accepting the consumption of winged termites. However, the associated *p*-value (Sig) of 0.751 suggests that the effect of disease perception on acceptance of consumption of winged termites is not statistically significant at the conventional 0.05 significance level implying that the null hypothesis would prevail that disease perception does not have a significant effect on consumers' acceptance of winged termites.

Thus, for every one unit of increase in the concerns of the consumers' health perceptions, the odds of consuming winged termites would decrease by a factor of 0.594. This means that consumers who are biased about their health by consuming winged termites have a probability of 59.4% of not consuming the winged termites hence not accepting the consumption of winged termites. Furthermore, the associated *p*-value of 0.000 suggests that the effect of consumers' health perception on acceptance of consumption of winged termites is statistically significant at the conventional 0.05 significance level implying that the null hypothesis shall be rejected and rather accept the alternative hypothesis that consumers' health perception has a significant effect on consumers' acceptance of winged termites.

On the other hand, for every one unit of consumers' societal

perception about termites, the odds of consuming winged termites would increase by a factor of 0.843. This means that consumers with societal perceptions such as tradition and culture have a probability of 84.3% of consuming the winged termites hence accepting the consumption of winged termites. Furthermore, the associated *p*-value of 0.000 suggests that the effect of consumers' societal perception on acceptance of consumption of winged termites is statistically significant at the conventional 0.05 significance level implying that the null hypothesis shall be rejected and rather accept the alternative hypothesis that consumers' societal perception has a significant effect on consumers' acceptance of winged termites.

Furthermore, for every one unit of increase in the consumers' behavior towards consumption of winged termites, the odds of consuming the winged termites would increase by a factor of 1.336. This means that consumer behavior is the perfect explanatory factor for acceptance of winged termites' consumption in northern Uganda. Furthermore, the associated *p*-value of 0.000 suggests that the effect of consumers' behavior of consumption of winged termites is statistically significant at the conventional 0.05 significance level implying that the null hypothesis shall be rejected and rather accept the alternative hypothesis that consumers' behavior has a significant effect on consumers' acceptance of winged termites.

On the whole, the logistic regression shows that consumers have accepted the consumption of winged termites in northern Uganda reflected by a constant of 1.066. Furthermore, the

most influencing factor in acceptance of winged termites by consumers in northern Uganda is the consumers' behavior towards the winged termites at a perfect probability of 1, followed by the consumers' societal/ cultural perception towards winged termites with a probability of 0.843. However, consumers who are biased by their health are most likely to reject consuming the winged termites evidenced by a probability of -0.594.

Descriptive Results on the Contribution of Winged Termites' Consumption on Food Security in Northern Uganda.

The question was posed to assess the contribution of winged termites' consumption on security of food in Northern Uganda. The methods were rated with the extent of agreement or disagreements i.e. strongly agree to strongly disagree. Findings from 384 community members are indicated in Table 6 below.

Table 6. The Contribution of Winged Termites' Consumption Acceptance on Security of Food in Northern Uganda.

Statement	Extent of (dis)agreement					Mean	Std. Dev
	SA	A	NS	D	SDA		
	f (%)	f (%)	f (%)	f (%)	f (%)		
Winged termites have many nutrients	270 (70.3)	104 (27.1)	10 (2.6)	- (0)	- (0)	3.56	1.132
Consumption of winged termites contribute to food availability	261 (67.9)	107 (27.8)	16 (4.3)	- (0)	- (0)	4.43	.895
Winged termites contribute to household income	249 (64.8)	98 (25.5)	31 (8.1)	6 (1.6)	- (0)	4.21	.895
Consumption of winged termites reduces malnutrition	232 (60.4)	87 (22.6)	51 (13.4)	14 (3.6)	- (0)	4.43	.817
Consumption of winged termites contributes to stability of food.	224 (58.3)	62 (16.2)	43 (11.2)	55 (14.3)	- (0)	3.97	1.137
I normally consume winged termites daily during harvesting seasons	203 (52.8)	46 (11.9)	64 (16.8)	71 (18.5)	- (0)	4.54	.627
Winged termites business is much profitable	198 (51.5)	38 (9.9)	55 (14.3)	50 (13.1)	43 (11.2)	4.31	.583
Winged termites consumption contributes to well being	146 (38.1)	42 (10.9)	49 (12.7)	76 (19.8)	71 (18.5)	4.71	.563
Eating winged termites reduces risks of some diseases	134 (34.9)	52 (13.6)	39 (10.2)	87 (22.6)	72 (18.7)	4.21	.576

Source: Primary Data (Community members) 2022

Table 6 represents the descriptive statistics on the contribution of winged termites' consumption acceptance on security of food in Northern Uganda. The results show that 97.4% of the respondents accepted to the statements that winged termites have many nutrients (Mean=3.56 and standard deviation 1.132); followed by consumption of winged termites contribute to food availability revealed by 67.9% of the respondents (Mean=4.43 and standard deviation 0.895); winged termites contribute to household income revealed by 90.3% of the respondents (Mean=4.21 and standard deviation 0.895); and

lastly, consumption of winged termites reduces malnutrition revealed by 83% of the respondents (Mean=4.43 and standard deviation .817).

In order to determine the level of prediction and significance of the winged termites' consumption acceptance and food security in Northern Uganda; the researcher used a regression model analysis and the F-ratio ANOVA to determine specific significance levels of relationship. The researcher used the age bracket as the predictor in the regression model as presented below.

Table 7. The regression model for the Contribution of Winged Termites' Consumption Acceptance on Security of Food in Northern Uganda.

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	24.276	56	2.023	36.692	.000 ^c
Residual	3.749	328	.055		
Total	28.025	384			

Predictors: (Constant), the major contributions of winged termites' consumption acceptance on food security in Northern Uganda include; winged termites have many nutrients, household income and reduces malnutrition, as well as consumption of winged termites contribute to food availability. From the ANOVA table, the prediction model was statistically significant, $F(12, 68) = 36.692$, $p\text{ value} < 0.000$ and accounted

for approximately 86.6% of the variance of the relationship between winged termites' consumption acceptance and food security in Northern Uganda. The major contributions of winged termites' consumption acceptance on security of food in Northern Uganda primarily predicted by continuously access to proper nutrients, household income and reduction of malnutrition.

Table 8. Coefficients Table.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1					
	(Constant)	3.913	.129	.000	.000
	Accessibility of winged termites	.245	.137	.245	.001
	Food availability	.304	.137	.304	.031
	Affordability of winged termites	.313	.137	.313	.042

a. Dependent Variable: Consumption of winged termites

Source: Primary data, 2022

The coefficients table shows that specifically, accessibility of winged termites accounts for 24.5% variation in the food security in Northern Uganda. Further, food availability accounts for 30.4% variation in the food security in Northern Uganda. Furthermore, affordability of winged termites accounts for 31.3% variation in the food security in Northern Uganda. The findings revealed that food availability and affordability of winged termites had the highest effect on the food security in Northern Uganda.

8. Qualitative Results

The first objective was also set to determine the socio-economic factors that influence consumer acceptance of winged termites in Northern Uganda. Interview schedules were used to solicit information from the agricultural officers, health workers and nutritionists. These categories of respondents were involved in answering interviews.

Table 9. Social Economic Factors that Influence Consumer Acceptance of Winged Insects.

Thematic Area	Frequency	Percentage
Consumer income	36	6.2
Consumer education level	33	1.42
Household Dynamics e. size, age sets	29	13.5
Consumer perception or attitude i.e. food for the poor	27	12.62
Affordability (cost of the termites)	25	11.68
Market proximity	24	11.22
Health issues e. nutritious, allergens, natural	21	9.81

Thematic Area	Frequency	Percentage
Cultural issues e.g taboo, cultural delicacy, cultural promotion	19	8.88
Total	214	

Source: Primary data (2022) (n=44)

In interviews, it was revealed that income of the consumers as a factor influencing consumer acceptance of winged termites in Northern Uganda; in fact, one of the nutritionists explained that; increase in household monthly income automatically increases the expected quantity of edible winged termites consumed by a household. Thus, as higher household income increases hence purchasing power of consumers of winged termites also doubles (Agricultural Officer from District A).

This implies that the increase in household income, the consumers' purchasing power of consumable winged termites also increases.

Another Other interviewed participant had these to say; Among rural dwellers, an increase in monthly income increased the expected quantity of EWT consumed by a household. Thus, as higher income increases disposable income hence purchasing power of consumers' (Agricultural worker from District B).

This implies that where an increase in household income, the consumption of winged termites automatically increases. This could be as a result of such individuals with high income, have enough financial resources to buy the necessary winged termites for their families.

The study also revealed that education of the consumers as another factor influencing consumer acceptance of winged termites in Northern Uganda. One of the interviewed participants had these to say: 'The demand and consumption for winged termites tend to decline among people with higher education qualifications, and this because it increases their consciousness of nutritional aspect of health implications of food intake. Similarly, with higher education raising the consumers' living standards and income, such group of educated consumers tend to consume more winged termites than the less educated due to their awareness of its nutritional content importance to their bodies and health' (Health worker from District B).

This implies that education levels of consumers greatly influence their acceptability to consume winged termites. Thus, the level one has attained in formal education, increase their expected quantity of winged termites consumed in the households.

The study further revealed that household size of the consumers as another factor influencing consumer acceptance of winged termites in Northern Uganda. One of the interviewed participants had these to say:

'The presence of elderly members in the household tends to

increase their demand for winged termites. On the other hand, an increase in the number of children below 5 years in the household also increases the quantity of winged termites' consumption'. (Nutritionists from district A).

Another interviewed health worker had these to say:

'As the number of household members aged above 5 years increased, the quantity of winged termites consumed increased among rural respondents. This could be attributed to most collections being in the rural areas. Rural dwellers collect and consume thus households with more members are able to collect and consume more winged termites. Similarly, households with more adult members consumed more cheese than those with only one adult or two adults and children' (Health officer from District B).

This implies that households with children consume higher quantities of edible winged termites than those without. Thus, as the number of household members aged above 5 years increased, the quantity of edible winged termites consumed increased among rural communities.

Additionally, the study revealed that nutritional content of winged termites as another factor influencing consumer acceptance of winged termites in Northern Uganda. One of the interviewed health workers had these to say:

'People prefer consumption of winged termites because they are nutritious and inexpensive food source as well as being rich source of protein that improve human diet. Winged termites often contain relatively more protein and minerals than meat, hence good food for nutrition among children' (Health worker from district B).

This implies that winged termites have high protein content and excellent production efficiency compared with other conventional food groups.

Another interviewed agricultural workers had these to say; 'On average, the perceived winged termites' attributes increased the expected quantity of EWT consumed in rural and urban households. Perceived good appearance, texture, taste, pleasant smell, hygiene, healthiness, naturalness, environmental friendliness and nutritional value of winged termites' increases the expected quantity consumed'. (Agricultural worker from District A).

This finding implies that consumers make their purchase and consumption decisions based on the tangible and intangible product attributes. Importance of these attributes to the consumers could have created a positive perception of EWT that increased the demand.

In interviews, it was revealed that individuals' culture and customer attitude as factors influencing consumer acceptance of winged termites in Northern Uganda; in fact, one of the agricultural officer explained that;

'Some cultures so not eat winged termites like pastoralists communities (Baloro) who have recently migrated to northern Uganda, and they look at eating winged termites for those who are cursed. Such consumer attitude and the way of thinking influence consumers purchase intention as well as perceived economic situation'. (Agricultural Extension

Worker, District A).

Another interviewed participant noted that;

‘Culture had a positive significant effect on winged termites acceptance among the rural respondents, implying that entomophagy is well rooted in their culture. Probably rural respondents attached greater value to their culture that increased their acceptance likelihood of EWT when they viewed it as a cultural delicacy’. (Nutritionist from District A).

This implies that individuals’ culture and customer attitude in those areas occupied by Balaro (pastoralists) have undermined the acceptability of winged termites’ consumption, and even those people (neighbours) who eat them, do it while hiding themselves to avoid being segregated. Attitudes towards entomophagy are determined by cultural and health issues.

Another interviewed participant had these to say;

‘Rural people perceive winged termites consumption as more cultural appropriate practice so increased consumption as a way of promoting their culture. Consumers with higher value for their culture would pay higher prices for fried and sundried EWT than those with lower value for their culture. Fried and sundried EWT are traditionally given as wedding prizes to signify long-term food security’ (Nutritionists from District B).

This implies that culture significantly and positively influenced the expected quantity of edible winged termites consumed among rural people.

In interviews, it was revealed that proximity of market place for winged termites as another factor influencing consumer acceptance of winged termites in Northern Uganda; in fact one of the agricultural officer explained that;

‘Winged termites tend to be most sold by vendors among the streets and hawkers within urban communities. Those consumers of winged termites in rural communities sometimes have less access to them for consumption. Longer distance to markets constrains access to food commodities, winged termites inclusive due to high transportation costs’ (Agricultural worker from district B).

This implies that the geographical location and accessibility of market for winged termites has an influence on their consumption.

In interviews, it was revealed that taste of the winged termites as another factor influencing consumer acceptance of winged termites in Northern Uganda; in fact one of the nutritionists explained that;

‘Some consumers of winged termites like them because of the smell and taste, and others reject consuming them because of the sensory appeal; that is, smell, colour, texture and taste of winged termites. For instance, some people vomit when their sense the smell of winged termites’. (Nutritionist from District B).

This implies that sensory qualities and taste in particular are critical determinants of food choice and preferences. Indeed, the consumer consciousness about what they eat, freshness, taste, safety and quality food products greatly influence consumers acceptability of consumption of winged termites.

Lastly, interviewed participants revealed that the acceptance of consumption of winged termites is also influenced by the potential allergic reactions and its side effects, fear of winged termites consumption contributes eating of heavy metals that cause adverse health effects, risk of pesticide food poisoning, consumers of winged termites experience antinutrients, and winged termites being considered to be contaminated. On average, an increase in the number of years spent in formal education of the household head increased the expected quantity of EWT consumed in rural and urban households. More educated household heads could have acquired supplementary knowledge about the nutritional, ecological and economic benefits of EWT consumption that developed positive perceptions and attitudes leading to higher demand of EWT. Similarly, more educated consumers consumed more cheese than the less educated due to their awareness of its nutritional content importance. Education is important in instilling ethics, understanding, transmitting knowledge and information among consumers.

Table 10. Contribution of Winged Termites’ Consumption on Food Security in Northern Uganda.

Thematic Area	Frequency	Percentage
Winged termites contain nutrients	38	16.38
Availability of food	35	15.09
Household income	33	14.22
Reduction of malnutrition	30	12.93
Food stability	27	11.64
Profitable business venture	26	11.21
Improved household wellbeing	23	9.91
Reduces risk of some diseases	20	8.62

Source: Primary data (2022)

Interview schedules were used to solicit information from the agricultural officers, health workers and nutritionists. These respondents were involved in answering interviews. The results show that winged termites have many nutrients. One of the interviewed nutritionists had these to say;

‘Winged termites contain nutrients such as protein, minerals and vitamins which are essential for human consumption. It is part of traditional diet in northern Uganda, and they are a rich source of protein, fat, zinc, and iron. Indeed, winged termites are a moderate source of n-3 fatty acids. Lipids from termites can be used in infant formula, the n-6: n-3 ratio lipids conforms to CODEX’. (Nutritionist from district A).

This implies that winged termites are part of high quality diets with high protein, zinc, and iron content. Winged termites provide proteins (amino acids such as methionine, lysine, and threonine), carbohydrate, fats, minerals (calcium, iron, zinc, phosphorous), some essential vitamins vitamin A, B complex, and C. Winged termites are rich in proteins, fibre, micronutrients and fatty acids thus an important food supplement for undernourished children and people living with HIV/AIDS.

The study revealed that consumption of winged termites contributes to food availability; in fact one of the agricultural officers explained that;

“.....winged termites are also a prized food source, they are packed full of nutrients and have a delicious nutty taste. They can be eaten alone as snack, typically flavoured with soy source, chili and pepper or lemon grass’ (Agricultural worker from District B).

More so, another interviewed nutritionist had these to say; ‘Winged termites are used as food in some cultures mainly in northern Uganda; however, they are mainly collected from the wild or around homestead for domestic consumption. Families look at them as a source of food paste and others just eat them in a raw form’ (Nutritionist from District B).

This implies that winged termites are used for making protein powders, energy bars, confectionary, beverages and more substantial foods. Termites are rich in vitamin A, Vitamin C, fat while anti-nutrient components is low. Winged termites is a good source of protein and other micro- and macronutrients and as such its consumption. The study further revealed that winged termites contribute to household income. One of the interviewed health workers noted that; ‘Winged termites contribute to household income especially among winged termites vendors. It has become a business especially in urban communities where youth tend to be involved in vending them’. (Health worker from District B).

This implies that apart from winged termites being unconventional resources of edible food with high economic and social importance, many people have been involved in self-employment especially vending of winged termites around urban centres. The study also revealed that consumption of winged

termites reduces malnutrition; in fact one of the agricultural workers explained that;

‘Winged termites are a good source of protein, fatty acids, vitamins, and minerals; and this make them a potential food source for healthy human diets. Some people tend to sun-dry them, or smoked-dried, and sometimes, it can be crushed to mush with a pestle and mortar, and be eaten with honey, while others fry/roast it in its own fat before consuming’. (Agricultural worker from District B).

This implies that lack of quality and diversity in complementary foods adversely affect infant and young child’s growth and nutritional status. Winged termites are not only used as emergency food during periods of famine, but are an integral part of the normal diet of some peoples according to the periods appearance of different edible species during the year.

Additionally, the study revealed that consumption of winged termites contributes to stability of food; in fact one of the extension worker explained that;

“.....winged termites consumption is a traditional practice in many parts and households in northern Uganda, has the potential to contribute to food security. Households consume winged termites as an alternative food source and being nutritious, it has helped to reduce on malnutrition among households. Additionally, these insects have been an important source of food that may contribute to improving human diet, particularly for people who suffer from malnutrition due to a deficit of protein...” (Extension workers from District A).

This implies that the importance of winged termites as a food source for humans is not surprising, since this is the group with the highest number of species in nature, thereby representing a vital biomass.

More so, the study revealed that people normally consume winged termites daily during harvesting seasons. One of the interviewed participants had these to say;

‘Very many people consumer winged termites during harvesting seasons especially in May, November and December every year’. (Agricultural workers from District B).

This implies that most of the people consume winged termites during seasons which tend to happen twice every year. From the field study, it was revealed that winged termites business is much profitable. One of the interviewed participants had these to say;

“.....winged termites being seasonal twice a year, most people tend to rush to buy them thus they are more profitable and the market demand is too high most especially in urban areas. Most urban community consumer winged termites and the demand is too high...” (Nutritionist from District A).

This concurs with the demand for winged termites are always too high in urban centres. The insects being seasonal, most people tend to run for them during those seasons. Since winged termites are a seasonal delicacy with a fairly constant

demand, in the market, the prices varies depending on how much is invested in gathering and preserving them.

The study also revealed that winged termites consumption contributes to wellbeing. One of the participants also noted that;

‘Winged termites contribute to the wellbeing of the people. Some enjoy eating them thus reducing on food insecurity, and other have resorted on winged termites as a source of income to have a better life style’ (Agricultural workers from District B).

This implies that there are brokers or middlemen in this business of winged termites, which contributes to the final prices. Winged termites are rich in Vitamin A and C, fat while anti-nutrient components is low.

Lastly, it was revealed that eating winged termites reduces risks of some diseases. One of the interviewed key informants noted that:

‘Winged termites are widely used in traditional medicine and consumed by human populations in several parts of the world. Winged termites are used in the treatment of various diseases that affect humans, such as influenza, asthma, bronchitis, whooping cough, sinusitis, tonsillitis and hoarseness’. (Agricultural Officer from District A).

This implies that winged termites are eaten around the world to increase protein and fat consumption that able to reduce of malnutrition and its related consequences like diseases.

This section therefore contains the discussion of the study as presented in above in order to establish whether the objectives of the study were achieved, to answer the research questions.

8.1. The Socio-economic Factors That Influence Consumer Acceptance of Winged Termites in Northern Uganda

The study noted that income of the consumers as a factor influencing consumer acceptance of winged termites in Northern Uganda. This concurs with [24] who noted that consumers who earn higher incomes would pay higher prices for fried and sundried winged termites than those who earn lower income. Moreover, this is expected because increase in income increases the consumers’ purchasing power. Besides, [43] found out that, higher income earners were more willing to pay prices premiums than lower income earners. Consumers’ income is important when studying food products demand it is from the income that the consumer allocates a portion for food purchase.[20] reported that increase in consumer income increases the purchasing power and improve the living standards. This implies that the increase in household income, the consumers’ purchasing power of consumable winged termites also increases. The increase in household monthly income automatically increases the expected quantity of edible winged termites consumed by a household. Thus, as higher household income increases hence purchasing power of consumers of winged termites also doubles. Similar finding was reported by

[30] where increase in income increased the consumers purchasing power of genetically modified food and improved their living standards. However, a higher monthly income will lower the expected quantity of winged termites consumed by a household in urban dwellers. Perhaps as income increases, the urban dwellers get access to other animal protein sources or they view EWT as food for the poor thus reducing its consumption as income increases. Similarly, perception of winged termites as food for the poor could reduce the likelihood of consumption.

The study also noted that education of the consumers positively influenced consumer acceptance of winged termites in Northern Uganda. This is in agreement with [44] who noted that more educated people could have acquired more knowledge about the nutritional, ecological and economic benefits of winged termites’ consumption thus influencing their positive perceptions and attitudes leading to higher demand of edible winged termites. On the other hand, [31] argued that highly educated consumers understood and appreciated the health implications of their diets, thus more willing to pay higher prices for healthy products than the less educated. Most highly educated consumers find the rural areas not fit for their residence and often move to urban areas as they get higher education. Education relates to the consumers knowledge and learning ability thus higher education increases access to nutritional information and enhances understanding of new ideas and concepts. This implies that education levels of consumers greatly influenced their acceptability to consume winged termites. Moreover, the level one has attained in formal education, increases their expected quantity of winged termites consumed in the households. The demand and consumption for winged termites tend to increase when among people with higher education qualifications, and this because it increase their consciousness of nutritional aspect of health implications of food intake. Similarly, with higher education raising the consumers’ living standards and income, such group of educated consumers tends to consume more winged termites than the less educated due to their awareness of its nutritional content importance to their bodies and health.

Household size of the consumers as another factor that positively influenced consumer acceptance of winged termites in Northern Uganda. More members above five in the household and presence of children below 5 years increased acceptance and consumption of winged termites which imply higher food and non food expenditure forcing the households to try out new low cost initiatives that could have additional economic benefits to meet their basic needs. This implies that households with children consumed higher quantities of edible winged termites than those without. Thus, as the number of household members aged above 5 years increased, the quantity of edible winged termites consumed increased among rural communities. [34] further noted that children require nutritious diets with all the necessary macro and micro elements for proper physical growth and mental development. Failure to get these elements at the required early life stage leads to

deficiency physical and mental disorders that can never be corrected at later life stages. The presence of elderly members in the household tends to also increase their demand for winged termites more so of the nutritional requirements of this group which EWT can offer cheaply.

Additionally, the study noted that nutritional content of winged termites a key factor influencing consumer acceptance of winged termites in the study area. Winged termites have high protein content and have excellent production efficiency compared with other conventional food groups. People prefer consumption of winged termites because they are nutritious and inexpensive food source as well as being rich source of protein that improve human diet. Winged termites often contain relatively more protein and minerals than meat, hence good food for nutrition among children. This concurs with [2] who argued that winged termites have been embraced as part of traditional diet among rural communities. The most seasonally collected edible insect in Western Kenya is the winged termite and like other insects, it is a good source of protein with high fat content (and thus energy) and many important minerals and vitamins. These winged termites have further received a major boost after the Food and Agricultural Organization (FAO) recommended them as a way of addressing food insecurity in developing nations [11].

The study further noted that on average, the perceived winged termites' attributes increased the expected quantity of EWT consumed in rural and urban households. Perceived good appearance, texture, taste, pleasant smell, hygiene, healthiness, naturalness, environmental friendliness and nutritional value of winged termites' increases the expected quantity consumed. According to [19] who noted that consumers use product attributes as a basis for evaluating the product in relation to the benefits they seek when buying the product. Perceived taste, naturalness, freshness and nutritional value were considered the most important attributes of winged termites. With the increase in consumer consciousness about what they eat, food products perceived natural are consumed in large quantities as they are associated with freshness, good taste, higher safety and superior quality. This finding implies that consumers make their purchase and consumption decisions based on the tangible and intangible product attributes. Importance of these attributes to the consumers could have created a positive perception of EWT that increased the demand.

Individuals' culture and customer attitude equally influenced consumer acceptance of winged termites in Northern Uganda. Personal values and their general way of living like quality nutrition and care for the environment play significant role in shaping consumer behavior. This implies that individuals' culture and customer attitude in those areas occupied by 'Balaro' (pastoralists) have undermined the acceptability of winged termites' consumption, and even those people (neighbours) who eat them, do it while hiding themselves to avoid being segregated. Attitudes towards entomophagy are determined by cultural and health issues. Some cultures so not eat

winged termites like pastoralists communities (Balaro) who have recently migrated to northern Uganda, and they look at eating winged termites as being cursed. Such consumer attitude and the way of thinking influence consumers purchase intention as well as perceived economic situation. This is in agreement with [4] who argued that most consumers of winged termites are associated with pro-entomophagy attitude and less food neophobic traits which can be of vital importance towards the promotion of winged termites as alternative food sources. According to [17], "*people are what they eat*" and so make their food choices depending on how they define themselves.

The study noted that rural people perceive winged termites consumption as more cultural appropriate practice so increased consumption as a way of promoting their culture. Consumers with higher value for their culture would pay higher prices for fried and sundried EWT than those with lower value for their culture. Fried and sundried EWT are traditionally given as wedding prizes to signify long-term food security. This finding is not surprising as rural areas are the major source of edible winged termites. Rural households could be relatively homogenous hence influencing each other culturally [18]. This finding corroborates that reported by [17] where, consumers' culture positively influenced their willingness to pay for traditional food products. Culture is a significant determinant and regulator of people's way of life especially their food consumption related behaviours. This finding further corroborates that reported by [44] where fitness of novel food in to consumer norms, beliefs and customs facilitated preference and increased the willingness to consume more units of the food. This implies that culture significantly and positively influenced the expected quantity of edible winged termites consumed among rural people.

The study also noted that proximity of market place for winged termites as another factor influencing consumer acceptance of winged termites in Northern Uganda. Urban consumers would pay higher prices for raw, fried, sundried and blanched EWT than rural consumers. This could be attributed to the transaction costs involved in moving EWT from rural to urban areas as most collections are majorly in rural areas. This implies that the geographical location and accessibility of market for winged termites has an influence on their consumption. Winged termites tend to be most sold by vendors among the streets and hawkers within urban communities. Those consumers of winged termites in rural communities sometimes have less access to them for consumption. Besides, [18] noted that there is a positive and significant variation in prices of raw, fried, sundried and blanched EWT and the consumers' location of residence.

Lastly, the study noted that taste of the winged termites as another factor influencing consumer acceptance of winged termites in Northern Uganda. This is in agreement with [10] who noted that consumers perceive senses such as taste and olfaction are useful in understanding food preferences, thus influencing the consumption and acceptability of winged termites

among households. [34] further noted that consumer perception underlies the success or failure of products in the market place. All stakeholders (consumers, producers, authorities) should fulfill their expected contribution in integrated manner and all efforts should be put in preventive control and consumption of safe and quality food. The rural and urban consumers' optimism about the consequences of consuming EWT based on these attributes could have influenced acceptance. The most desirable food attributes are freshness, naturalness, and minimal processing [2]. This implies that sensory qualities and taste in particular are critical determinants of food choice and preferences. The consumer consciousness about what they eat, freshness, taste, safety and quality food products greatly influence consumers acceptability of consumption of winged termites. Some consumers of winged termites like them because of the smell and taste, and others reject consuming them because of the sensory appeal; that is, smell, colour, texture and taste of winged termites. For instance, some people vomit when they sense the smell of winged termites.

8.2. The Contribution of Winged Termites' Consumption on Food Security in Northern Uganda

Food security entails availability, affordability, accessibility and utilization and as such the study looked at how acceptance and consumption contributed to these four components. Winged termites contain nutrients such as protein, minerals and vitamins which are essential for human consumption. It is part of traditional diet in northern Uganda, and they are a rich source of protein, fat, zinc, and iron. Indeed, winged termites are a moderate source of n-3 fatty acids. Lipids from termites can be used in infant formula, the n-6: n-3 ratio lipids conforms to CODEX. This is in agreement with [37] who asserted that winged termites are a good source of food; being rich in proteins, fats, vitamins and many essential mineral nutrients, and thus provide food security for low income households. This implies that winged termites are part of high quality diets with high protein, zinc, and iron content. Winged termites provide proteins (amino acids such as methionine, lysine, and threonine), carbohydrate, fats, minerals (calcium, iron, zinc, phosphorous), some essential vitamins vitamin A, B complex, and C. Winged termites are rich in proteins, fibre, micronutrients and fatty acids thus an important food supplement for undernourished children and people living with HIV/AIDS. Consequently, winged termite's product development should be encouraged, however, there are reports of already developed products such as protein powders, energy bars, confectionary, beverages and more substantial foods. Being a prized food source packed full of nutrients and have a delicious nutty taste, winged termites can be eaten alone as snack, typically flavoured with soy source, chili and pepper or lemon grass [3].

The study noted that consumption of winged termites contributed to food availability especially for those in conflict areas of the study area. These are people residing in refugee

camps hence their source of livelihood has been disrupted as well as regular source of food thus collecting winged termites enables them to access alternative food. [12] report indicated that malnutrition and food insecurity have gradually reduced among households especially those in rural northern Uganda that ate winged termites. Thus, presence and consumption of winged termites is a good prospect to help address food insecurity issues related to a global rising population, without simultaneously harming the environment and further recommended popularization of winged termites as an option for increasing sources of foods in the world. Besides, [2] argued that winged termites are rich in essential food nutrients necessary for human and livestock feeding.

The study further revealed that winged termites contributed to household income. This is in agreement with [3] who argued that during winged termites' seasons, the number of people involved in selling of winged termites doubled. Many people get involved in vending of winged termites especially in market places, along the streets and other congested places to boost their household income, and extend food sources to the community. This implied that apart from winged termites being unconventional resources of edible food with high economic and social importance, many people have been involved in self-employment especially vending of winged termites around urban centres. Winged termites contributed to household income especially among winged termites' vendors. It has become a business especially in urban communities where youth tend to be involved in vending them.

The study also noted that consumption of winged termites reduces malnutrition. This concurs with [23] who asserted that winged termites had been reported to be rich in essential nutrients and could be suitable alternative to animal source-foods in complementary feeding when available. This implies that lack of quality and diversity in complementary foods adversely affect infant and young child's growth and nutritional status. Winged termites are not only used as emergency food during periods of famine, but are an integral part of the normal diet of some peoples according to the periods appearance of different edible species during the year. Winged termites are a good source of protein, fatty acids, vitamins, and minerals; and this make them a potential food source for healthy human diets. Some people tend to sun-dry them, or smoke-dry, and sometimes, it can be crushed to mush with a pestle and mortar, and be eaten with honey, while others fry/roast it in its own fat before consuming.

Consumption of winged termites further contributed to stability of food. This concurs with [2] who asserted that entomophagy, as the practice of using insects as a part of the human diet has played a vital role in the history of human nutrition in Africa, and the rest of the world, asserting importance of winged termites as a food source for humans since this is the group with the highest number of species in nature, thereby representing a vital biomass. Winged termites' consumption is a traditional practice in many parts and households in northern Uganda, has the potential to contribute to food security.

Households consume winged termites as an alternative food source and being nutritious, it has helped to reduce on malnutrition among households. Additionally, these insects have been an important source of food that may contribute to improving human diet, particularly for people who suffer from malnutrition due to a deficit of protein. More so, the study noted that people normally consume winged termites daily during harvesting seasons. This is in agreement with [17] who argued that most species of subterranean termites swarm during the spring and summer months, typically on a warm day which calm winds after a rainfall. Dry-wood termites typically swarm during the late summer or fall months, from August through November. This implied that most of the people consume winged termites during seasons which tend to happen twice every year. Very many people consumer winged termites during harvesting seasons especially in May, November and December every year.

From the field study, it noted that winged termite's business is a form of livelihood especially when in season. This concurs with [23] who said that the insects being seasonal, most people tend to run for them during those seasons. Since winged termites are a seasonal delicacy with a fairly constant demand, in the market, the prices vary depending on how much is invested in gathering and preserving them. Also, the time during the season is another factor as well as the quantity. This coincides with the demand for winged termites which are always too high in urban centres. Winged termites being seasonal twice a year, most people tend to rush to buy them thus they are more profitable with the high demand in urban areas. This is further asserted by [20] who argued that people's standards of living, income level and general wellbeing increased for those involved in winged termites' business especially vendors. It further contributes to employment through it value chain activities and actor involved such as brokers or middlemen. With the high nutritional content, they contribute to the well being of the consumers. Some enjoy eating them thus reducing on food insecurity, and other have resorted on winged termites as a source of income to have a better life style.

Lastly, it was noted that eating winged termites reduces risks of some diseases. This is in agreement with [2] who asserted that winged termites are commonly used insects in traditional popular medicine. They are used in the treatment of various diseases that affect humans. This implied that winged termites are eaten around the world to increase protein and fat consumption that are able to reduce malnutrition and its related consequences like diseases. Winged termites are widely used in traditional medicine for treatment of diseases such as influenza, asthma, bronchitis, whooping cough, sinusitis, tonsillitis and hoarseness [23].

9. Summary, Conclusion and Recommendations

This chapter therefore contains the summary of findings,

conclusion and recommendations of the study as presented in chapter four in order to establish whether the objectives of the study were achieved, to answer the research questions. These follow the sequence of research questions as developed from the research objectives. The areas for further study are equally presented in this chapter.

10. Summary of Findings

Consumers perceive winged termites positively as food with desirable attributes, convenient and culturally appropriate. Positive perception of edible winged termite characteristics is the major determinant of acceptance and quantity consumed in rural and urban consumers. Consumers' participation in off-farm income generating activities and location of residence are the major significant determinants of market prices for raw, fried, sun-dried and blanched edible winged termites. In rural and urban households, more educated decision makers were likely to accept EWT consumption than the less educated. Formal education could have developed knowledge on the nutritive and ecological benefit of using insects as food among participants which influenced their attitudes and perceptions towards winged termites' consumption making the highly educated more likely to accept. The increase in income reduces the likelihood of accepting EWT as food in rural and urban households. Perhaps as income increases, the respondents have access to other animal protein sources or they view termites as food for the poor thus reducing its acceptance.

Similarly, a perception of edible insects as food for the poor could reduce the likelihood of consumption acceptance as income increases. Perceived convenience of EWT increases the expected quantity of EWT consumed by a household among rural and urban dwellers. EWT could have fitted well into consumers' trends and needs of saving time and generating income for others. Thus, convenience plays an important role when consumers have to decide whether to consume a certain food product or not. Moreover, food products perceived as easily accessible, easy to store, available for use when needed and easy to cook have a higher demand. Furthermore, consumers demand for edible insects increases when they know that other chain actors like farmers or producers are employed, earn higher incomes and have improved livelihood.

11. Conclusions

From the findings in chapter four, the following conclusions were drawn. Reference to objective one, it is concluded that income of the consumers, availability of winged termites, education of the consumers, are the major socio-economic factors that influence consumer acceptance of winged termites in northern Uganda. It concluded that consumers with winged-insects perception of having diseases have a probability of 4.5% of accepting the consumption of winged termites. Consumers

who are biased about their health by consuming winged termites have a probability of 59.4% of not consuming the winged termites hence not accepting the consumption of winged termites. Consumers with societal perceptions such as tradition and culture have a probability of 84.3% of consuming the winged termites hence accepting the consumption of winged termites. Consumer behavior is the perfect explanatory factor for acceptance of winged termites' consumption in northern Uganda. Therefore, the most influencing factor in acceptance of winged termites by consumers in northern Uganda is the consumers' behavior towards the winged termites at a perfect probability of 1, followed by the consumers' societal/cultural perception towards winged termites with a probability of 0.843. However, consumers who are biased by their health are most likely to reject consuming the winged termites evidenced by a probability of -0.594.

Basing on the objective two, it is concluded that winged termites have many nutrients, consumption of winged termites contribute to food availability, reduces malnutrition, and ensures stability of food, as well as improving on household income. These are the major contributions of winged termites' consumption on food security in Northern Uganda. Therefore, the findings concluded that food availability and affordability of winged termites had the highest effect on the food security in Northern Uganda.

12. Policy

From the findings of the study, the following recommendations were made; The study recommended that commercialization of edible insects' value chain can start with edible winged termites as consumers already have a positive perception of it. There is considerable need for an opportunity to improve the productivity and healthfulness of insect husbandry and processing. It is also recommended that formal education sector officials can take an active role in engendering edible insects especially winged termites into the food chain through the school feeding programmes. The study recommended that the marketers should target consumers residing in urban areas and participating in off-farm income generating activities for higher profits. Thus, the comprehension of driving forces behind behavioral intentions toward winged termites' restaurant is a necessary for its greater market penetration which eventually contributes to increase the sustainable consumption behavior among restaurant consumers. The study recommended that there is need to educate consumers about the environmental and nutritional benefits of winged termites. Individual's product knowledge level affects the process of purchase behavior since consumers with a high or low degree of product knowledge differ in their evaluation of products/services which in turn influence decision-making.

14. Areas of Further Research

The researcher carried this study in order to examine the "Assessing the Acceptability of Winged Termites as an Alternative Food Source in Northern Uganda"; but the study was not exhaustive owing to constraints in terms of scope, time and finance. Further research is therefore needed in areas such as:

Choice experiment can be used instead of ANOVA, regression model and Pearson's Correlation in a further study.

This study focused on winged termites whose mass production methods are unknown. Therefore, further similar research can be conducted using crickets or grasshoppers that are easier to produce in commercial farms.

This research was carried out in an area where consumers are familiar with edible winged termite consumption. Further research can be carried out in other areas where the consumption of edible insects like winged termites is not a common practice. In conclusion, more research should be done about the acceptability of winged termites as an alternative food source in Uganda so as to compare with results got from northern Uganda so as to draw a ground for recommendations.

Abbreviations

FAO	Food Agriculture Organisation
P	Proportional Value
%	Percentages
Sig.	Significance

Conflicts of Interest

The authors declare that there is no conflict of interest.

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